

GENERATION OF MIXED ELEMENT MESHES USING A FLEXIBLE REFINEMENT APPROACH: ADVANTAGES AND LIMITATIONS

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A good mesh for control volume methods is a Delaunay mesh where the Voronoi point of each boundary/interface element is inside the element itself or inside a neighboring element by internal faces. In addition, the mesh should not contain large angles and too high edge-vertex connectivity. This paper discusses the last improvements and the outreach of a 3D mixed element mesh generator for control volume methods based on an extension of modified octrees. Incomplete versions of this mesh generator have been already published in [1,2], but this is the first time a complete version is available that can be applied to complex examples. The mesh generator begins the fitting of the geometry by enclosing the domain with its smallest cuboid. Cuboid edges are refined along one, two or three coordinate axis at the most convenient edge point obtained from the intersection between the input geometry and the current element. This step finishes when the intersection between the input geometry and each cuboid is exactly fitted using cuboids, prisms and pyramids of rectangular basis, and rectangular tetrahedra (well-shaped macro-elements) or a fractal configuration is recognized. In the next step, each element is refined along the required axis until the point density specified by the user is obtained. Element edges are normally bisected except when their edges already contain Steiner-points previously inserted. From the available Steiner points, the one whose associated refinement generates sons with smallest aspect ratio is chosen. Subsequently, the mesh is done 1-irregular in order to obtain a graded mesh and to generate proper local tessellations, i.e, tessellations that satisfy the control volume requirements. A co-spherical set of points, that satisfies the Delaunay condition is accepted as final element if its tessellation into (more simple) basic elements would require the addition of new edges (diagonals) or vertices on its surface.

The last improvements are (a) algorithms to recognize input geometry configurations that are reproduced when cuboids are refined (fractal configurations), (b) strategies to reduce the number of points inserted while generating the final mesh, and (c) the recognition of all co-spherical elements that can be accepted as final elements.

As result, (1) a flexible refinement allows a straightforward fitting of complex device geometries and a quick fulfilling of the density requirements, (2) the new point insertion strategies to generate a conforming final mesh have strongly reduced the number of final points, and (3) the use of several final elements avoids the generation of too small and too large dihedral angles, too high vertex-edge connectivity, and the insertion of diagonals to divide rectangles. The problems of the current implementation are (a) it can model a limited class of complex inputs (2) the algorithms used to recognize final elements from co-spherical point configurations are still not robust enough.

Acknowledgments: This work is partially supported by Fondecyt 1037602.

References

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- [2] N. Hitschfeld. "Generalization ...", *Geometric Modeling ...*, Springer, 260-272, 1997.